The Distribution Function of the Event-by-Event Average p_T

M. J. Tannenbaum [a]

[a] *Brookhaven National Laboratory, Upton, NY 11973*

Presented by: M. J. Tannenbaum

Abstract

For statistically independent emission, a closed form of the distribution function for M_{p_T}, the event-by-event average p_T, can be obtained. A recent NA49 measurement satisfies this condition and a distribution is obtained which is in excellent agreement with the NA49 measurement. If the transverse momenta, p_{T_i}, of individual particles on a given event are compatible with being statistically independent, the distribution of M_{p_T}, the event-by-event average transverse momentum, for a fixed number of n particles per event, is a Gamma distribution:

$$f(y) = f_\Gamma(y, np, nb) = \frac{nb}{\Gamma(np)}(nby)^{np-1}e^{-nby}$$

where the variable y represents M_{p_T}. The parameters p and b are obtained from the mean and standard deviation of the semi-inclusive p_T distribution averaged over all events, assumed to be a Gamma distribution. The full distribution taking into account the variation of n for central collisions is

$$f(y) = \sum_{n=n_{\rm min}}^{n_{\rm max}} f_{\rm NBD}(n, 1/k, \langle n\rangle)\, f_\Gamma(y, np, nb)$$

where the multiplicity distribution for central collisions is assumed as Negative Binomial with parameters $\langle n\rangle$ and $1/k$ obtained from the quoted mean and standard deviation of the number of particles for central collisions. The gamma distribution, with its exponential upper tail, which is rather different from a gaussian, is also relevant to recent preliminary event-by-event analyses from STAR.

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